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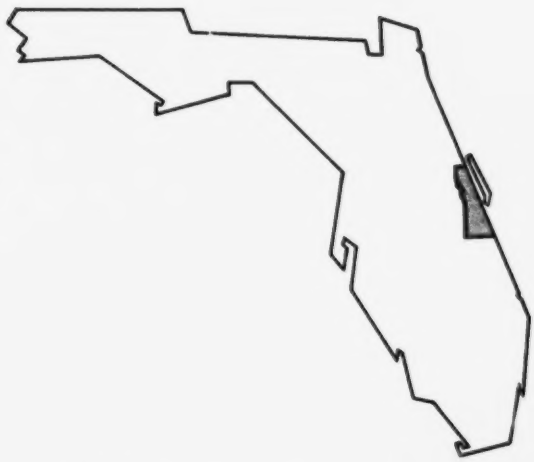
FLOOD INSURANCE STUDY

WAVE HEIGHT ANALYSIS



BREVARD COUNTY, FLORIDA
UNINCORPORATED AREAS

MARCH 16, 1982

Federal Emergency Management Agency

COMMUNITY NUMBER-125092

ANALYSIS OF WAVE HEIGHTS
FOR
BREVARD COUNTY, FLORIDA
(UNINCORPORATED AREAS)

FEDERAL EMERGENCY MANAGEMENT AGENCY

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1.0 INTRODUCTION

1.1 Background and Purpose

The Federal Emergency Management Agency recently adopted recommendations by the National Academy of Sciences to include prediction of wave heights in Flood Insurance Studies for coastal communities subject to storm surge flooding, and to report the estimated wave crest elevations as the base flood elevations on Flood Insurance Rate Maps (FIRMs).

Previously, FIRMs were produced showing only the stillwater storm-surge elevations due to the lack of a suitable and generally applicable methodology for estimating the wave crest elevations associated with storm surges. These stillwater elevations were subsequently stipulated in community flood plain management ordinances as the minimum elevation of the first floor of new construction. Communities and individuals had to consider the additional hazards of velocity waters and wave action on an ad hoc basis. Because there has been a pronounced tendency for buildings to be constructed only to meet minimum standards, without consideration of the additional hazard due to wave height, increasing numbers of people could unknowingly be accepting a high degree of flood-related personal and property risk in coastal areas subject to wave action. Therefore, the Federal Emergency Management Agency has pursued the development of a suitable methodology for estimating the wave crest elevations associated with storm surges. The recent development of such a methodology by the National Academy of Sciences (Reference 1) has led to the adoption of wave crest elevations for use as the base flood elevations in coastal communities.

Brevard County, Florida, is located on the open coast and is subject to flooding from tidal surges associated with hurricanes.

This region has experienced flooding from several hurricanes. Among the more severe were the storms of July-August 1926 and August-September 1964. The center of the 1926 hurricane entered the coast near Cocoa Beach, Florida, and passed close to Titusville. Maximum winds of 60 to 70 miles per hour were reported at Titusville. The center of Hurricane Cleo (1964) passed through Brevard County in a north-northwesterly direction almost parallel to the coast.

The purpose of this study is to revise the FIRM for the unincorporated areas of Brevard County to include the effects of wave action associated with flooding from the Atlantic Ocean at the open coast, Indian River, Banana River, Sykes Creek, and Sebastian Creek.

2.0 INVESTIGATIONS

2.1 Previous Studies

Stillwater elevations for hurricane surges with 10-, 50-, 100-, and 500-year return periods were determined by the National Oceanic and Atmospheric Admini-

stration (NOAA) for the open coast of the Atlantic Ocean, Indian River, Banana River, Sykes Creek, and Sebastian Creek. The 100-year stillwater elevations were used as base flood elevations for the coastal areas on the FIRM that is currently in effect for Brevard County (Reference 2).

The NOAA storm-surge elevations were determined using a computer model of hurricane forces (References 3 and 4). Weather records were analyzed to determine probable atmospheric pressure drop, radius of maximum winds, and forward speed and direction of storms occurring near the study area. Using these data, in conjunction with the astronomic tides and bathymetric data, stillwater elevations for various probabilities were calculated. Results of these calculations were calibrated against tide gage records and high-water marks for historical events at various locations along the coast.

Tidal backwater elevations for Indian River, Banana River, Sykes Creek, and Sebastian Creek were determined by NOAA using high-water marks from storms and data from available reports by the U.S. Army Corps of Engineers and Brevard County (References 5 and 6).

The 10-year surge elevations used for the wave height analysis for Indian and Banana Rivers, and Sykes Creek were increased based on revised elevations determined by NOAA in 1977 (Reference 7) and engineering judgment.

The 100-year stillwater elevations developed by NOAA for the open coast, Indian River, Banana River, Sykes Creek, and Sebastian Creek were used as the starting water-surface elevations for the wave height analysis presented herein.

This report is authoritative for purposes of the National Flood Insurance Program, and data presented herein supersede all previous flood elevation determinations.

2.2 Data Collection and Review

All available source data applicable for the wave height analysis were collected and reviewed. Because wave height calculations are based on such parameters as the size and density of vegetation, natural barriers (sand dunes), buildings, and other manmade structures, it was necessary to obtain detailed information on the physical and cultural features of the study area.

Officials of Brevard County and the incorporated coastal communities within the county were contacted for maps and other possible data sources to be used in the analysis. In addition, the Florida Department of Natural Resources, Bureau of Beaches and Shores; the John F. Kennedy Space Center; the Florida Department of Transportation; the U.S. Army Corps of Engineers, Jacksonville District; and the National Ocean Survey were contacted and all available data sources were obtained.

The principal source materials used for the wave height analysis are described below.

a. Topographic data (ground elevations, seawall elevations, and locations of physical features) were determined using U.S. Geological Survey

topographic maps at a scale of 1:24,000, with a contour interval of 5 feet (Reference 8); Florida Department of Natural Resources topographic maps at a scale of 1:1,200, with a contour interval of 2 feet (Reference 9); National Ocean Survey storm evacuation maps at a scale of 1:62,500, with a contour interval of 5 feet (Reference 10); and beach profiles of the immediate Atlantic coast area obtained from the Florida Department of Natural Resources (Reference 11).

Recent stereoscopic aerial photography at a scale of 1:12,000 was used to determine vegetation and building parameters and to supplement the topographic maps for locations of physical features in Brevard County (References 12 and 13).

2.3 Wave Height Analysis

The methodology for analyzing the effects of wave heights associated with coastal storm surge flooding is described in the National Academy of Sciences report (Reference 1). This method is based on the following major concepts. First, depth-limited waves in shallow water reach a maximum breaking height that is equal to 0.78 times the stillwater depth. The wave crest is 70 percent of the total wave height above the stillwater level. The second major concept is that wave height may be diminished by dissipation of energy due to the presence of obstructions such as sand dunes, dikes and seawalls, buildings, and vegetation. The amount of energy dissipation is a function of the physical characteristics of the obstruction and is determined by procedures prescribed in Reference 1. The third major concept is that wave height can be regenerated in open fetch areas due to the transfer of wind energy to the water. This added energy is related to fetch length and depth.

Wave heights were computed along transects (cross section lines) that were located along the coastal areas in accordance with the Users Manual for Wave Height Analysis (Reference 14). The transects were located along the coastline as shown in Figure 1. The transects were located with consideration given to the physical and cultural characteristics of the land so that they would closely represent conditions in their locality. Transects were spaced close together in areas of complex topography and dense development. In areas having more uniform characteristics, they were spaced at larger intervals. It was also necessary to locate transects in areas where unique flooding existed and in areas where computed wave heights varied significantly between adjacent transects.

Each transect was taken perpendicular to the shoreline and extended inland to a point where wave action ceased. Along each transect, wave heights and elevations were computed considering the combined effects of changes in ground elevation, vegetation, and physical features. The stillwater elevations for the 100-year flood were used as the starting elevations for these computations. Wave heights were calculated to the nearest 0.1 foot, and wave elevations were determined at whole-foot increments along the transects. The location of the 3-foot breaking wave for determining the terminus of the V Zone (area with velocity wave action) was also computed at each transect. Table 1 provides a listing of the transect locations and stillwater starting elevations, as well as maximum wave crest elevations in Brevard County.

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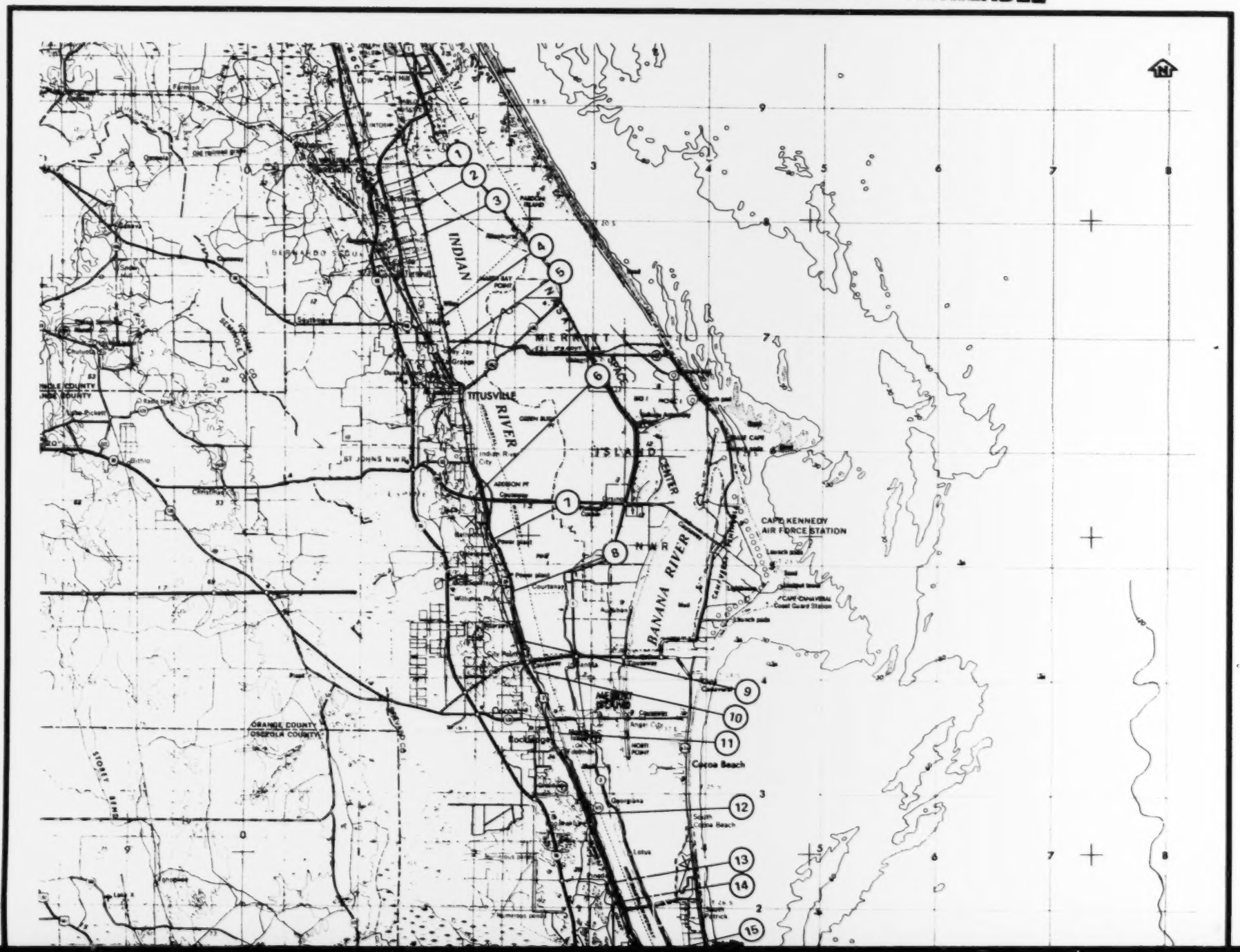

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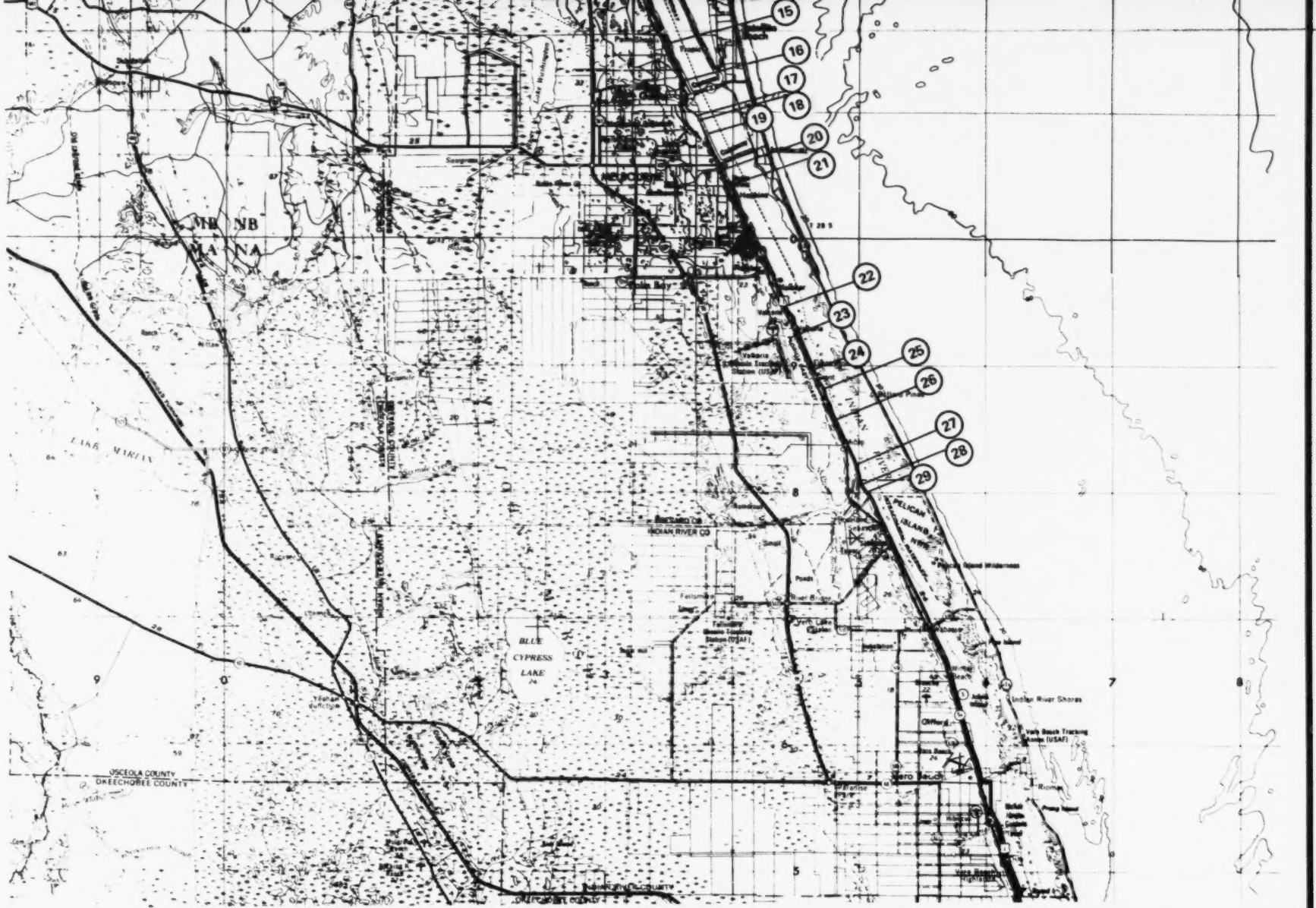

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FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

BREVARD COUNTY, FL

APPROXIMATE SCALE

6 0 6 12 18 MILES

TRANSECT LOCATION MAP

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Table 1.
Transect Locations, Stillwater Starting Elevations, and Maximum Wave Crest Elevations

Transect	Location	Elevation (Feet NGVD) Stillwater	Wave Crest
1	Brevard County - From John F. Kennedy Space Center westward across Indian River to the limit of inundation by the 100-year storm surge between Coral Avenue and Sunset Avenue	4.0[1]	5[1]
2	Brevard County - From John F. Kennedy Space Center westward across Indian River to the limit of inundation by the 100-year storm surge just north of Big Flounder Creek	4.0[1]	5[1]
3	Brevard County - From John F. Kennedy Space Center westward across Indian River to the limit of inundation by the 100-year storm surge between Davis Road and Grandperrin Road	4.0[1]	5[1]
4	Brevard County - From John F. Kennedy Space Center westward across Indian River to the limit of inundation by the 100-year storm surge at Hammock Road approximately 650 feet south of intersection with Wiley Avenue	4.0[1]	5[1]
5	Brevard County - From John F. Kennedy Space Center westward across Indian River to the limit of inundation by the 100-year storm surge; crosses Florida East Coast Railroad approximately 350 feet south of Jay Jay Road	4.0[1]	5[1]
6	Brevard County - From John F. Kennedy Space Center westward across Indian River to the limit of inundation by the 100-year storm surge at Riveredge Drive just south of Titusville	4.0[1]	5[1]
7	Brevard County - From John F. Kennedy Space Center westward across Indian River to the limit of inundation by the 100-year storm surge at Bellwood	4.0[1]	5[1]
8	Brevard County - From John F. Kennedy Space Center westward across Indian River to the limit of inundation by the 100-year storm surge at Hardeeville	4.0[1]	5[1]

[1]Indian River

Table 1. (Cont'd)
Transect Locations, Stillwater Starting Elevations, and Maximum Wave Crest Elevations

Transect	Location	Elevation (Feet NGVD) Stillwater	Wave Crest
9	Cape Canaveral/Brevard County - From Atlantic coastline westward across Banana River, Merritt Island, and Indian River to the limit of inundation by the 100-year storm surge; passes through John's Court in Ridge Manor	4.0[2]	5[2]
10	Brevard County/Cape Canaveral/Cocoa - From Atlantic coastline westward across Banana River, Merritt Island, and Indian River; crosses State Highway A1A between Taft Avenue and Wilson Avenue in Cape Canaveral	4.0[2]	5[2]
11	Cocoa Beach/Brevard County/Rockledge - From Atlantic coastline westward across Banana River, Merritt Island, and Indian River; crosses North Banana River Drive between Angel Avenue and Fowler Drive	5.0[2]	7[2]
12	Brevard County - From Atlantic coastline westward across Banana River, Merritt Island, and Indian River; crosses State Highway A1A between Summer Street and Crescent Beach Drive	8.0[3]	12[3]
13	Brevard County - From Atlantic coastline westward across Banana River, Merritt Island, and Indian River to the limit of inundation by the 100-year storm surge at U.S. Highway 1 at intersection with Aspen-Wall	8.0[3]	12[3]
14	Brevard County - From Atlantic coastline westward across Banana River, Merritt Island, and Indian River to the limit of inundation by the 100-year storm surge approximately 2700 feet north of Pineda Expressway	8.0[3]	12[3]
15	Satellite Beach/Brevard County/Melbourne - From Atlantic coastline westward across Banana River, Merritt Island, and Indian River; crosses State Highway A1A approximately 75 feet south of intersection with Grant Avenue in Satellite Beach	6.0[1]	8[1]

[1] Indian River
[2] Banana River
[3] Atlantic Ocean

Table 1. (Cont'd)
Transect Locations, Stillwater Starting Elevations, and Maximum Wave Crest Elevations

Transect	Location	Elevation (Feet NGVD) Stillwater	Wave Crest
16	Indian Harbour Beach/Brevard County/Melbourne - From Atlantic coastline westward across Banana River, Merritt Island, and Indian River; crosses Merritt Island approximately 750 feet south of Banana River Drive	6.0[1]	8[1]
17	Melbourne/Brevard County - From Atlantic coastline westward across Indian River; crosses State Highway AlA approximately 100 feet north of intersection with Ocean View Lane in Melbourne	6.0[1]	8[1]
18	Brevard/Melbourne County - From Atlantic coastline westward across Indian River; crosses Carmel Road between Putnam Drive and Beach Street in Brevard County	8.3[2]	13[2]
19	Brevard County/Melbourne - From east side of Indian River westward across Indian River; crosses Shoreview Drive near intersection with South Patrick Drive	6.0[1]	8[1]
20	Indialantic/Melbourne - From Atlantic coastline westward across Indian River; crosses Miramar Avenue (State Highway AlA) just south of intersection with Tenth Avenue in Indialantic	8.3[2]	13[2]
21	Melbourne Beach/Brevard County/Melbourne - From Atlantic coastline westward across Indian River; crosses Oak Street (State Highway AlA) approximately 450 feet north of intersection with Atlantic Street in Melbourne Beach	7.0[1]	9[1]
22	Brevard County/Malabar - From Atlantic coastline westward across Indian River; crosses State Highway AlA approximately 1350 feet north of Richards Avenue	8.3[2]	13[2]

[1] Indian River
[2] Atlantic Ocean

Table 1. (Cont'd)
Transect Locations, Stillwater Starting Elevations, and Maximum Wave Crest Elevations

Transect	Location	Elevation (Feet NGVD) Stillwater	Wave Crest
23	Brevard County - From east side of Indian River westward across Indian River to the limit of inundation by the 100-year storm surge approximately 2350 feet south of Valkaria Road	7.0[1]	9[1]
24	Brevard County - From east side of Indian River westward across Indian River to the limit of inundation by the 100-year storm surge approximately 250 feet east of intersection of Avenue B and 4th Street	7.0[1]	9[1]
25	Brevard County - From Atlantic coastline westward across Indian River; crosses U.S. Highway 1 at intersection with Cooke Avenue	8.3[2]	13[2]
26	Brevard County - From Atlantic coastline westward across Indian River to the limit of inundation by the 100-year storm surge at U.S. Highway 1 approximately 2900 feet north of Barefoot Boulevard	8.3[2]	13[2]
27	Brevard County - From Atlantic coastline westward across Indian River to the limit of inundation by the 100-year storm surge at U.S. Highway 1 near 14th Street	8.3[2]	13[2]
28	Brevard County/Indian River County - From Atlantic coastline westward across Indian River and Sebastian Creek; crosses State Highway A1A approximately 2200 feet north of Sebastian Inlet	8.3[2]	13[2]
29	Brevard County/Indian River County - From inside of Sebastian Inlet westward across Indian River to the limit of inundation by the 100-year storm surge	8.0[1]	11[1]

[1]Indian River
[2]Atlantic Ocean

Figure 2 is a profile for a typical transect illustrating the effects of energy dissipation and regeneration on a wave as it moves inland. This figure shows the wave elevations being decreased by obstructions, such as buildings, vegetation, and rising ground elevations, and being increased by open, unobstructed wind fetches. Actual wave conditions in Brevard County may not necessarily include all the situations illustrated in Figure 2.

After analyzing wave heights along each transect, wave elevations were interpolated between transects. Various source data were used in the interpolation, including topographic maps (References 8, 9, and 10), beach profiles (Reference 11), and aerial photographs (References 12 and 13), along with engineering judgment. Controlling features affecting the elevations were identified and considered in relation to their positions at a particular transect and their variation between transects.

2.4 Results

No shore protection structures or dunes are located within the 100-year coastal flood plain between Cape Canaveral and Cocoa Beach, or south of Indian Harbour Beach along the open coast. Between Cocoa Beach and Satellite Beach, shore protection measures are limited to scattered individual structures. These structures, along with vegetated dunes with elevations of approximately 12 to 14 feet, are expected to remain intact during a 100-year storm tide and are considered effective wave energy dissipators.

The maximum wave crest elevation developed at the open coast shoreline is 12 feet for the northern two-thirds of the county, and 13 feet for the southern one-third of the county.

Between Cape Canaveral and Cocoa Beach, the Atlantic coastline is characterized by an abrupt foreshore slope, rising to an elevation of approximately 8 feet which completely dissipates all incoming waves. Behind the foreshore slope is a relatively flat berm that is approximately 100 feet wide. This berm acts against erosion, which occurs from waves breaking on the foreshore during a hurricane. Rising ground elevations at the leeward side of the berm stop further inundation by the 100-year storm surge.

Waves along the Atlantic coastline between Cocoa Beach and Satellite Beach are completely dissipated and the 100-year storm surge is stopped by an ascendant beach slope that rises to an elevation of approximately 8 feet, scattered seawalls, and dunes. South of Indian Harbour Beach, waves are completely dissipated and the 100-year storm surge is stopped by the beach slope, which rises to an elevation of approximately 10 to 12 feet. At the leeward side of the beach, vegetated dunes (with elevations of approximately 16 to 20 feet) provide additional protection against storm tides more severe than the 100-year surge.

Along Indian River, from the northern county limits to Palm Shores, waves of approximately 2 feet are generated during a 100-year storm tide. North of Hubert Humphrey Bridge (State Highway 520) along this reach, the wave crest

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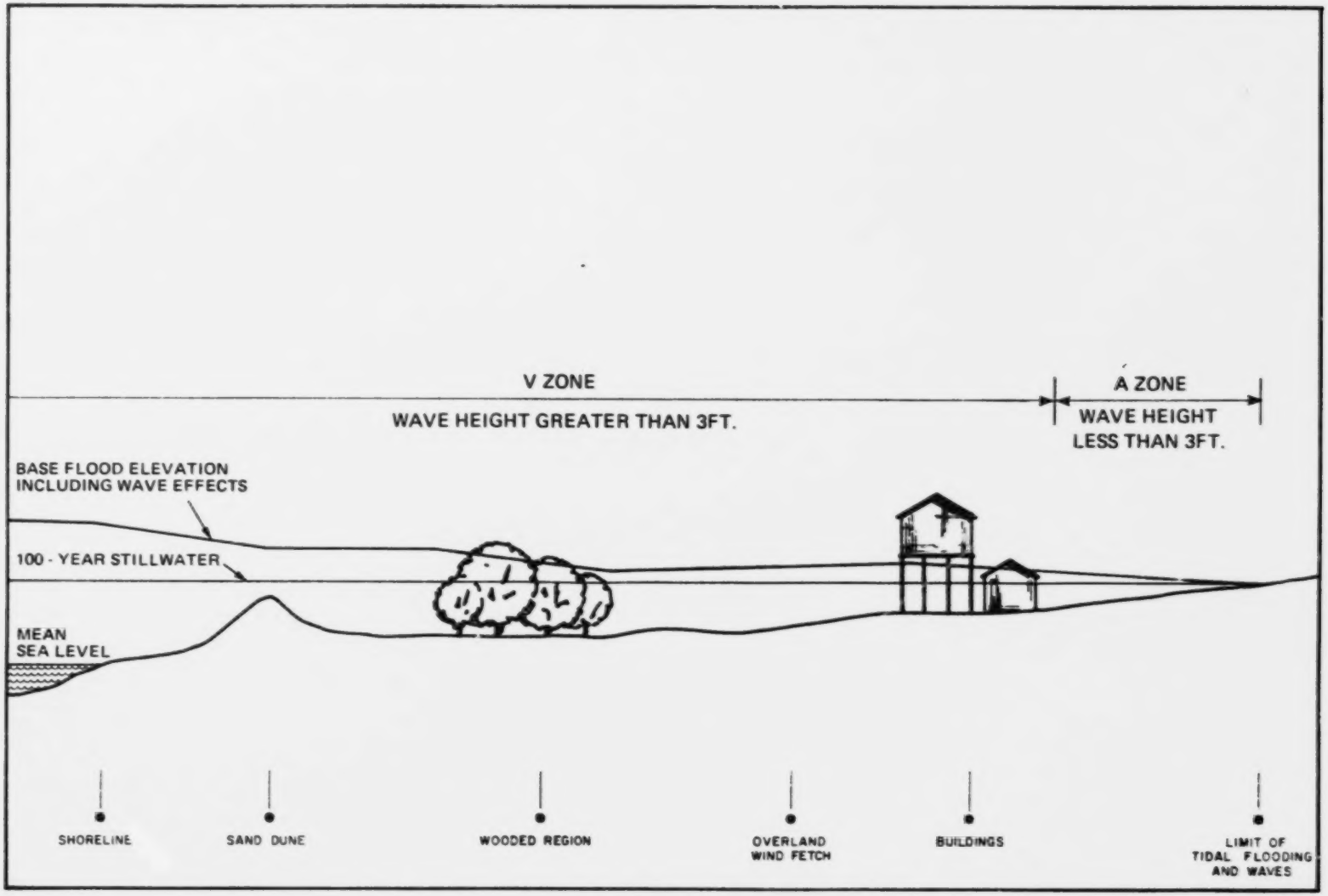

FIGURE 2
TYPICAL TRANSECT SCHEMATIC

elevation is 5 feet; south of the bridge (due to higher stillwater elevations), the wave crest elevation is 6 feet. From Palm Shores to Melbourne Causeway, waves of approximately 2.5 feet, with a wave crest elevation of 8 feet, are generated. From Melbourne Causeway to Grant, waves of approximately 3 feet, with a wave crest elevation of 9 feet, are generated. South of Grant, waves of approximately 3.5 feet, with a wave crest elevation of 11 feet, can be expected during a 100-year storm tide.

No shore protection structures are located along Indian River from the northern county limits to Titusville. Along this reach, waves are completely dissipated by the Florida East Coast Railroad embankment on the west side of Indian River. Rising ground elevations to the west of the railroad stop further inundation by the 100-year storm surge. South of Titusville, the western shoreline of Indian River is generally characterized by a steep shoreline that completely dissipates all incoming waves and stops inundation by the 100-year storm surge. In those areas where the shoreline slopes more gradually away from the river, waves are dissipated by vegetation and buildings located in low-lying areas adjacent to the river. Shore protection measures along Indian River south of Titusville are limited to scattered individual bulkheads. These structures are expected to remain intact during a 100-year storm tide.

Along Banana River, from the John F. Kennedy Space Center to State Highway 520, waves of approximately 2 feet, with a wave crest elevation of 5 feet, are generated during a 100-year storm tide. From State Highway 520 to Satellite Beach, a higher stillwater elevation, coupled with 2- to 2.5-foot high-waves, yields a wave crest elevation of 7 feet. South of Satellite Beach, waves of approximately 2 feet, with a wave crest elevation of 7 feet, can be expected during a 100-year storm tide.

On the western shore of Banana River, from the John F. Kennedy Space Center to the southern tip of Horti Point, waves are dissipated by a combination of vegetation and buildings located in low-lying areas adjacent to the river. Numerous bulkheads have been constructed in this area and these structures are considered to remain intact during a 100-year storm tide. Portions of Horti Point will be completely inundated during a 100-year storm tide.

Inside Newfound Harbor on Banana River, waves are dissipated by rising ground elevations and vegetation.

On Merritt Island, from Rockwell to the southern portion of the island, waves from Banana River are dissipated abruptly at the steep shoreline and the 100-year storm tide is stopped. From just north of Tropic to the southern tip of Merritt Island, waves are dissipated by a combination of buildings and vegetation located within the 100-year flood plain and rising ground elevations. Portions of the southern tip of Merritt Island will be completely inundated by a 100-year storm tide. Scattered bulkheads have been constructed along the southern portion of Merritt Island and these structures are considered to remain intact during a 100-year storm tide.

Along Sykes Creek, waves of approximately 1 foot, with a wave crest elevation of 5 feet, are generated during a 100-year storm tide. North of Bennett Causeway, the 1-foot wave is dissipated by vegetation, and the 100-year storm surge

is stopped by rising ground elevations. South of Bennett Causeway, the 1-foot wave is completely dissipated, and the 100-year storm surge is stopped by the bulkheads that protect the extensive residential development on the western side of Sykes Creek. These bulkheads are expected to remain intact during a 100-year storm tide and are considered effective wave energy dissipators.

At the mouth of Sebastian Creek, wave heights of approximately 4 feet, with a wave crest elevation of 10 feet, are generated across Indian River. These waves are quickly dissipated by drag from the shoreline. From just inside the mouth to the confluence of the North and South Prongs of Sebastian Creek, wave heights of approximately 1 foot are generated across Sebastian Creek. Upstream of the Florida East Coast Railroad bridge, a wave crest elevation of 7 feet will be encountered; downstream of the railroad, a higher surge elevation yields a wave crest elevation of 8 feet. The 1 foot wave is completely dissipated by rapidly rising ground elevations and buildings located within the 100-year flood plain along River Oak and Canal Drive. Several bulkheads have been constructed along Sebastian Creek. These structures were judged to be of insufficient height to have an effect on incoming waves. The 100-year storm surge is stopped by rising ground elevations along Sebastian Creek.

3.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

A prime purpose of the National Flood Insurance Program is to encourage local governments to adopt sound flood plain management programs designed to reduce future flood losses. The FIRM for Brevard County has been revised to incorporate the latest available information, including wave height data, to assist the county in developing the most appropriate and effective flood plain management measures.

3.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the Federal Emergency Management Agency as the base flood for purposes of flood plain management. This flood has a 1 percent chance of being equalled or exceeded each year and is expected to be exceeded once on the average during any 100-year period. The risk of having a flood of this magnitude or greater increases when periods longer than 1 year are considered. For example, over a 30-year period, there is a 26 percent chance of experiencing a flood equal to or greater than the 100-year flood. The 500-year flood plain is also shown on the FIRM to indicate areas of moderate flood hazards.

Areas inundated by the 100-year flood are shown as A and V Zones on the community's FIRM. It is in these areas that the Federal Emergency Management Agency requires local communities to exercise flood plain management measures as a condition for participation in the National Flood Insurance Program.

3.2 Base Flood Elevations

Areas within the county studied by detailed engineering methods have base flood elevations established in A and V Zones. These are the elevations of

the base (100-year) flood relative to the National Geodetic Vertical Datum of 1929. In coastal areas affected by wave action, base flood elevations are generally maximum at the open coast shoreline. These elevations generally decrease in a landward direction at a rate dependent on the presence of obstructions capable of dissipating the wave energy. Where possible, changes in base flood elevations have been shown in 1-foot increments on the FIRMs. However, where the scale did not permit, 2- or 3-foot increments were sometimes used. Base flood elevations shown in the wave action areas represent the average elevation within the zone. Current program regulations generally require that all new construction be elevated such that the first floor, including basement, is above the base flood elevation in A and V Zones.

3.3 Velocity Zones

The U.S. Army Corps of Engineers (Reference 15) has established the 3-foot breaking wave as the criterion for identifying coastal high hazard zones. This was based on a study of wave action effects on structures. This criterion has been adopted by the Federal Emergency Management Agency for the determination of V Zones. Because of the additional hazards associated with high-energy waves, the National Flood Insurance Program regulations require much more stringent flood plain management measures in these areas, such as elevating structures on piles or piers. In addition, insurance rates in V Zones are higher than those in A Zones with similar numerical designations.

The location of the V Zone is determined by the 3-foot breaking wave as discussed previously. The detailed analysis of wave heights performed in this study allowed a much more accurate location of the V Zone to be established. The V Zone generally extends inland to the point where the 100-year flood depth is insufficient to support a 3-foot breaking wave.

4.0 INSURANCE APPLICATION

The assignment of proper actuarial insurance rates requires that frequency and depth of flooding be estimated as accurately as possible. Because waves can add considerably to expected flood depths, it is important that insurance rates consider this additional hazard. The Federal Emergency Management Agency has developed a process to transform the data from this study into flood insurance criteria. This process includes the determination of Flood Hazard Factors and the designation of flood insurance zones.

4.1 Flood Hazard Factors

The Flood Hazard Factor (FHF) is the device used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHF are used to set actuarial insurance premium rate tables.

The FHF is shown as a three-digit code that expresses the difference between the 10- and 100-year flood elevations to the nearest 0.5 foot. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF

is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, the FHF is computed to the nearest foot.

4.2 Flood Insurance Zones

After wave elevations for the 100-year storm surge were determined and mapped, the study areas were divided into zones, each having a specific flood potential and FHF. Each zone was assigned one of the following flood insurance zone designations:

Zones V8, V10, and V11:	Special Flood Hazard Areas inundated by the 100-year flood, and that have additional hazards due to velocity (wave action); base flood elevations shown, and zones subdivided according to FHFs.
Zones A4, A5, A7, and A9:	Special Flood Hazard Areas inundated by the 100-year flood, with base flood elevations determined and zone designations assigned according to the FHFs.
Zone B:	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood plain, including areas that are protected from the 100- and 500-year floods by dike, levee, or other water control structure; and areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot, or where the contributing drainage area is less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas not subject to flooding by the 500-year flood. Zone C is not subdivided.

Table 2, "Flood Insurance Zone Data," summarizes the FHFs, flood insurance zones, and base flood elevations for each flooding source in the study area.

4.3 Flood Insurance Rate Map

After flood insurance zones were established for the study area, the FIRM for Brevard County was revised to incorporate the new zone information. This map (Exhibit 1) contains the official delineation of flood insurance zones and base flood elevations.

In preparing the revised FIRM, some zone boundaries and the Atlantic Ocean shoreline were revised to reflect updated topographic information. Corporate limits and cultural features were revised using current county maps (Refer-

Table 2. Flood Insurance Zone Data

Flooding Source	Stillwater Elevation 10-Year	Stillwater Elevation 100-Year	FHF	Zone	Base Flood Elevation (Feet NGVD)*
Atlantic Ocean					
Open Coast					
North of Indian Harbour Beach	4.7	8.0	050	V10	10 to 12
			045	A9	8 to 10
South of Indian Harbour Beach	4.7	8.3	055	V11	10 to 13
			045	A9	8 to 10
Indian River					
North of State Highway 520	3.0	4.0	020	A4	4,5
State Highway 520 to Palm Shores	4.0	5.0	020	A4	5,6
Palm Shores to Melbourne Causeway	4.5	6.0	025	A5	6 to 8
Melbourne Causeway to Grant	4.5	7.0	040	V8	9
			035	A7	7 to 9
South of Grant	4.5	8.0	055	V11	10,11
			045	A9	8 to 10

*Due to map scale limitations, base flood elevations shown on the FIRM may represent average elevations for the zones depicted.

Table 2. Flood Insurance Zone Data (Cont'd)

Flooding Source	Stillwater Elevation 10-Year	Stillwater Elevation 100-Year	FHF	Zone	Base Flood Elevation (Feet NGVD)*
Atlantic Ocean (Cont'd)					
Banana River					
North of State Highway 520	3.0	4.0	020	A4	4,5
State Highway 520 to Satellite Beach	4.0	5.0	020	A4	5 to 7
South of Satellite Beach	4.5	6.0	025	A5	6,7
Sykes Creek	3.0	4.0	020	A4	4,5
Sebastian Creek					
Upstream of Florida East Coast Railroad	2.3	6.0	045	A9	6,7
			035	A7	6
Downstream of Florida East Coast Railroad	3.3	7.0	055	V11	9,10
			045	A9	7 to 9

*Due to map scale limitations, base flood elevations shown on the FIRM may represent average elevations for the zones depicted.

ences 16 and 17). In addition, approximate zone boundaries throughout the county were revised using U.S. Geological Survey Water's Edge/Wetlands Maps received from the county (Reference 18).

5.0 OTHER STUDIES

FIRMs for the adjacent Volusia and Indian River Counties, and the incorporated communities of Cape Canaveral, Cocoa Beach, Indian Harbour Beach, Indialantic, and Melbourne Beach, and the Flood Insurance Studies for Palm Bay, Satellite Beach, Melbourne, and Malabar are being revised concurrently with Brevard County to include wave height analysis. These revised studies will be in agreement with this study. The revised studies for Malabar and Melbourne will be in agreement with this study with the exception of zone numbers for the Indian River flooding. This difference results from a minor variation in the 10-year surge elevations used for the wave height analyses.

The Flood Hazard Boundary Map for the Town of Palm Shores, the Flood Insurance Rate Map for Titusville, and the Flood Insurance Studies for Cocoa and Rockledge are not being revised at this time to include wave height analysis, and will not be in agreement with this study.

6.0 REFERENCES

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3. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Technical Memorandum NWS TDL 52, SPLASH (Special Program to List Amplitudes of Surges from Hurricanes): Part I, Landfall Storms, C.P. Jelesnianski, 1972

4. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Technical Memorandum NWS TDL 52, SPLASH; Part II, General Track and Variant Storm Conditions, C.P. Jelesnianski, 1974

5. U.S. Department of the Army, Corps of Engineers, House Document No. 352, 90th Congress, 2nd Session, July 8, 1968

6. Brevard County, Florida, Board of County Commissioners, Basic Utilities Study, Prepared by Ralph M. Parsons Company in Collaboration With Brevard County Planning Department, January 1969

7. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Personal Communication Between John F. Miller and Tom Hansen, U.S. Army Corps of Engineers, Jacksonville District, July 14, 1977

8. U.S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 5 feet: Oak Hill, Florida (1949), Photorevised (1970); Pardon Island, Florida (1949), Photorevised (1970); Mims, Florida (1949), Photorevised (1970); Wilson, Florida (1949), Photorevised (1979); Titusville, Florida (1949), Photorevised (1970); Orsino, Florida (1976); False Cape, Florida (1976); Sharpes, Florida (1949), Photorevised (1970); Courtenay, Florida (1976); Cape Canaveral, Florida (1976); Cocoa, Florida (1976); Cocoa Beach, Florida (1976); Eau Gallie, Florida (1949), Photorevised (1970); Tropic, Florida (1949), Photorevised (1970); Melbourne West, Florida (1949), Photorevised (1970); Melbourne East, Florida (1949), Photorevised (1970); Grant, Florida (1949), Photorevised (1970); Sebastian NW, Florida (1949), Photorevised (1970); Fellsmere, Florida (1949), Photorevised (1970); Sebastian, Florida (1949), Photorevised (1970)

9. Florida Department of Natural Resources, Bureau of Beaches and Shores, Brevard County Coastal Construction Control Line, Preliminary, Scale 1:1,200, Contour Interval 2 feet, Photographed 1980

10. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Survey, Storm Evacuation Maps, T-15076, T-15077, T-15084, and T-15085, Scale 1:62,500, Contour Interval 5 feet: New Smyrna Beach, Florida (1977); Titusville, Florida (1977); Melbourne, Florida (1977); Palm Bay, Florida (1978)

11. Florida Department of Natural Resources, Bureau of Beaches and Shores, Brevard County Beach Profiles, Scale 1:600, 1972

12. Federal Emergency Management Agency, Stereoscopic Aerial Photography of Brevard County, Florida, Scale 1:12,000, 1981

13. Florida Department of Transportation, Stereoscopic Aerial Photography of Brevard County, Florida, Scale 1:12,000, 1980

14. Federal Emergency Management Agency, Users Manual for Wave Height Analysis, Revised February 1981

15. U.S. Department of the Army, Corps of Engineers, Galveston District, Guidelines for Identifying Coastal High Hazard Zones, June 1975

16. Brevard County, Florida, North Half, Brevard County, Florida, Sheriff's Index, Scale 1:31,680, September 1976

17. Brevard County, Florida, South Half, Brevard County, Florida, Sheriff's Index, Scale 1:31,680, January 1977

18. Brevard County Planning and Zoning Department, Water's Edge/Wetland Maps, Scale 1:24,000, Contour Interval 5 feet: Brevard County, Florida (1981)